

CLAIMS

We claim:

1 1. An analog-to-digital converter comprising:

2 a waveguide adapted to receive an optical signal and an
3 analog electrical signal, wherein the waveguide is adapted to
4 provide a desired time delay to the optical signal based on a
5 value of the analog electrical signal;

6 means for receiving the optical signal with the time delay
7 and providing an output optical signal having a wavelength based
8 on the time delay;

9 a demultiplexer adapted to route the output optical signal
10 to one of a plurality of optical paths based on the wavelength;

11 photodetectors adapted to convert optical signals in the
12 optical paths into electrical signals; and

13 a discriminating circuit adapted to receive the electrical
14 signals and determine which of the optical paths provided the
15 output optical signal to provide a digital electrical output
16 signal corresponding to the analog electrical signal.

1 2. The analog-to-digital converter of Claim 1, further
2 comprising a fiber optic circulator adapted to provide the
3 optical signal to the waveguide and the optical signal with the
4 time delay to the receiving means.

1 3. The analog-to-digital converter of Claim 1, wherein
2 the receiving means comprises:

3 a fiber assembly adapted to provide self-phase modulation
4 and dispersion to the optical signal or to an optical clock
5 signal; and

6 an optical switch adapted to receive the optical signal and
7 the optical clock signal and provide the output optical signal.

1 4. The analog-to-digital converter of Claim 3, further
2 comprising filters adapted to filter the optical signals in the
3 optical paths.

1 5. The analog-to-digital converter of Claim 1, wherein
2 the receiving means comprises:

3 dispersive elements adapted to impart a chirp onto the
4 optical signal and an optical clock signal; and

5 an optical nonlinearity device adapted to receive the
6 optical signal and the optical clock signal and to provide the
7 output optical signal.

1 6. The analog-to-digital converter of Claim 5, wherein
2 the frequency of the optical signal and the optical clock signal
3 are slewed at the same rate but in opposite directions, at the
4 same rate and direction, or at a different rate but in the same
5 direction.

1 7. The analog-to-digital converter of Claim 1, wherein
2 the waveguide comprises a chirped distributed Bragg reflector.

1 8. The analog-to-digital converter of Claim 1, wherein
2 the waveguide comprises at least one layer of an electro-
3 optically active material having a refractive index controlled
4 by the analog electrical signal.

1 9. A method of providing analog-to-digital conversion,
2 the method comprising:

3 providing an optical signal pulse having a time delay
4 controlled by an analog electrical signal;

5 converting the optical signal pulse with the time delay to
6 an optical output signal pulse having a wavelength based on the
7 time delay; and

8 providing a digital electrical output signal, corresponding
9 to the wavelength of the optical output signal pulse, wherein a
10 value of the digital electrical output signal is based on a
11 value of the analog electrical signal.

1 10. The method of Claim 9, further comprising:

2 routing the optical output signal pulse to one of a
3 plurality of paths based on the wavelength;

4 converting the optical output signal pulse to an electrical
5 signal; and

6 determining the value of the digital electrical output
7 signal based on which path provided the optical output signal
8 pulse.

1 11. The method of Claim 10, further comprising filtering
2 the optical output signal pulse.

1 12. The method of Claim 10, wherein the converting
2 comprises providing self-phase modulation and dispersion to the
3 optical signal pulse with the time delay.

1 13. An analog-to-digital converter system comprising:

2 an analog delay modulator adapted to receive an analog
3 electrical signal and to provide optical pulses having time
4 delays determined by the analog electrical signal;

5 a fiber assembly adapted to receive the optical pulses or
6 clock pulses and provide self-phase modulation and dispersion;

7 an optical switch, coupled to the fiber assembly, adapted
8 to receive the optical pulses and the clock pulses and provide
9 output optical pulses having wavelengths corresponding to the
10 time delays; and

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11 a discriminator adapted to receive the output optical
12 pulses and provide digital electrical output signals based on
13 the wavelengths.

1 14. The system of Claim 13, wherein values of the digital
2 electrical output signals are based on values of the analog
3 electrical signal.

1 15. The system of Claim 13, wherein the analog delay
2 modulator comprises:

3 an optical pulse generator adapted to provide the optical
4 pulses; and

5 a waveguide adapted to receive the optical pulses and the
6 analog electrical signal and apply the time delays to the
7 optical pulses under the control of the analog electrical
8 signal.

1 16. The system of Claim 15, wherein the analog delay
2 modulator further comprises a fiber optic circulator adapted to
3 route the optical pulses to and from the waveguide.

1 17. The system of Claim 16, wherein the waveguide
2 comprises a chirped distributed Bragg reflector.

1 18. The system of Claim 13, wherein the discriminator
2 comprises:

3 a demultiplexer adapted to route the output optical pulses
4 to one of a plurality of paths based on the wavelength;

5 photodetectors adapted to convert the output optical pulses
6 to electrical signals; and

7 a discriminating circuit adapted to receive the electrical
8 signals and provide the digital electrical output signals based
9 on which path carried the corresponding output optical pulses.

1 19. The system of Claim 18, further comprising filters,
2 coupled to the photodetectors, and adapted to filter the output
3 optical pulses.

1 20. The system of Claim 13, wherein the demultiplexer
2 comprises an arrayed-waveguide grating demultiplexer or a
3 wavelength-independent star coupler.

1 21. The system of Claim 13, wherein the discriminating
2 circuit provides frequency shift keying detection.

1 22. The system of Claim 13, wherein the optical pulses are
2 pulse position modulated optical signals.

1 23. An analog-to-digital converter comprising:

2 an optical pulse generator adapted to receive an analog
3 electrical signal and provide optical pulses having time delays
4 determined by the analog electrical signal; and

5 an optical pulse discriminator adapted to receive the
6 optical pulses and provide a digital electrical signal, wherein
7 the digital electrical signal is based on the analog electrical
8 signal.

1 24. The analog-to-digital converter of Claim 23, wherein
2 values of the digital electrical signal are digital
3 representations of corresponding values of the analog electrical
4 signal.

1 25. The analog-to-digital converter of Claim 23, wherein
2 the optical pulse generator comprises a waveguide adapted to
3 receive the optical pulses and provide the time delays to the
4 optical pulses under control of the analog electrical signal.

1 26. The analog-to-digital converter of Claim 25, wherein
2 the waveguide comprises at least one layer of electro-optically
3 active material having refractive index variations which form a
4 chirped distributed Bragg reflector, wherein the analog
5 electrical signal controls an index of refraction of the
6 electro-optically active material.

1 27. The analog-to-digital converter of Claim 25 wherein
2 the optical pulse generator further comprises a fiber optic
3 circulator adapted to direct the optical pulses to and from the
4 waveguide.

1 28. The analog-to-digital converter of Claim 23, wherein
2 the optical pulse discriminator comprises:

3 a fiber assembly adapted to spectrally broaden and chirp
4 the optical pulses or optical clock pulses;

5 an optical switch adapted to receive the optical pulses and
6 the optical clock pulses, after the optical pulses or the
7 optical clock pulses are spectrally broadened and chirped by the
8 fiber assembly, and provide an optical output pulse
9 corresponding to each of the optical pulses and having a
10 wavelength based on the time delay of the optical pulse;

11 a demultiplexer adapted to direct each of the optical
12 output pulses to one of a plurality of optical paths based on
13 its wavelength;

14 photodetectors adapted to convert the optical output pulses
15 to electrical output signals; and

16 a discriminating circuit adapted to receive each of the
17 electrical output signals and provide the corresponding digital
18 electrical signal.

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1 29. The analog-to-digital converter of Claim 28, wherein
2 the corresponding digital electrical signal for each of the
3 electrical output signals is based on which of the optical paths
4 carried the corresponding optical output pulse, wherein a value
5 of the digital electrical signal is a digital representation of
6 a corresponding value of the analog electrical signal.

1 30. The analog-to-digital converter of Claim 23, wherein
2 the optical pulse discriminator comprises:

3 dispersive elements adapted to impart a chirp onto the
4 optical pulses and optical clock pulses;

5 an optical nonlinearity device adapted to receive the
6 optical pulses and the optical clock pulses and provide an
7 optical output pulse corresponding to each of the optical pulses
8 and having a wavelength based on the time delay of the optical
9 pulse;

10 a demultiplexer adapted to direct each of the optical
11 output pulses to one of a plurality of optical paths based on
12 its wavelength;

13 photodetectors adapted to convert the optical output pulses
14 to electrical output signals; and

15 a discriminating circuit adapted to receive each of the
16 electrical output signals and provide the corresponding digital
17 electrical signal.

1 31. The analog-to-digital converter of Claim 30, wherein
2 the corresponding digital electrical signal for each of the
3 electrical output signals is based on which of the optical paths
4 carried the corresponding optical output pulse, wherein a value
5 of the digital electrical signal is a digital representation of
6 a corresponding value of the analog electrical signal.